CHAPTER 6

STRUCTURES

The Program Manager must confer with the Project Support Division in the office of Chief Transportation Engineer concerning policies and criteria for approvals related to structure issues.

6.1 Major Structure - Bridge

Major structures are bridges and culverts with a total length greater than 20 ft., and retaining walls with both a total length greater than 100 ft. and a maximum exposed height at any section of over 5 ft. The length is measured along the centerline of roadway for bridges and culverts, and along the top of the wall for retaining walls. Overhead sign structures (sign bridges, cantilevers and butterflies extending over traffic) are major structures also (Refer to the **Structural** chapter within **Part II** of this manual for minimum design loading). Major structures should be analyzed individually for the most optimal design. Any substantial costs of deviations from the most economical design need to be considered in the structure selection process and must be approved by the Chief Transportation Engineer.

6.2 Culvert

An adequate survey of channel cross-section and channel length, normally 500 ft. upstream and downstream from the roadway alignment centerline, is needed. An analysis should be made of the existing structure capacity adequacy and associated roadway alignment (horizontal and vertical). A drainage basin survey using United States Geological Survey (USGS) maps, drainage reference maps, plans and profile sheets, and geology evaluations should be conducted.

A qualified engineer with knowledge of hydrology and hydraulics shall complete hydraulic design of a drainage structure, such as a concrete box culvert. However, this knowledge requirement varies according to the complexity of design.

Develop the most economical alternative between a concrete box culvert and a bridge. Concrete box culverts are likely to be economically viable for structures less than 23 ft. in length, when:

- The cover on the concrete box culvert is less than 30 ft. and the concrete box culvert clear span is less than 23 ft.
- The cover on the concrete box culvert is less than 3 ft. and the concrete box culvert clear span is less than 36 ft.

A cost comparison should be made to determine what structure is the best choice to be constructed. The above criteria should not override the results of this cost

comparison. Project grade adjustments should be included in the cost comparison alternatives.

6.3 Hydraulic Design

The design of highway drainage requires a hydrologic analysis to determine the magnitude and frequency of storm runoff and a hydraulic analysis to locate and size the drainage facilities doing the following:

- Work with the Environmental Programs staff to identify environmental assessments.
- Identify floodplain assessments, including any significant encroachments.
- Make preliminary estimates, and finalize structure design, scour, erosion protection, storm runoff, and any hydraulic drainage.
- Identify underground utilities near existing and proposed drainage features.

If environmental factors are to be affected by hydrology, a complete written assessment should be documented and submitted to the Project Manager.

Erosion control procedures are addressed in the DCRA Erosion & Sediment Control Handbook and in the DOH, Standards and Specifications for Soil Erosion and Sediment Control. Hydraulic design needs will be determined during the project scoping process.

NOTE: Procedures for the design of pipe culverts, concrete box culverts, and bridge hydraulics are outlined in the **Structural** chapter within **Part II** of this manual.

6.4 Major Structure - Special

The Project Manager shall submit Structure Reports as well as the plans for reviews to the FHWA. The local FHWA Division will review those submittals and may forward them to the Washington Headquarters for approval as appropriate.

The Structure Selection Reports submitted for review and approval shall include environmental concerns and suggested mitigation measures, and studies of alternate spans and bridge types.

6.5 Pedestrian Overpass/Underpass

The design of pedestrian over/underpasses should accommodate accessibility for the physically handicapped, and bicycle traffic, where warranted. Public safety features such as vertical clearance, fencing, decking requirements and lighting should be included in the design of the over/underpasses. Design criteria for over/underpass are in the **Structural** chapter within **Part II** of this manual.

6.6 Architectural/Aesthetic Treatment

Generally, the Commission on Fine Arts and communities require that efforts should be made to accomplish aesthetically pleasing features for bridges in the District. This entails aesthetic treatment of parapets, railings and concrete surfaces, including stone facing on certain structures. It also entails the provision of improved streetscape for the street projects.

Visually appealing structures should be adopted and developed early before final design commences, as inclusion of these details is not easily accomplished after the structure design has begun. Some aesthetically pleasing features can be incorporated in a structure at low cost while others increase cost significantly. New or untried features and treatments must be thoroughly investigated before incorporating those details in a structure. Aesthetics are important in high profile, frequently viewed structures.

6.7 Geotechnical Studies

Refer to the Pavement Chapter within this manual.

6.8 Structure Condition Report

During the conceptual stage of a project, the Project Manager shall develop a structure selection report for all major structures in accordance with the **Structural** chapter within **Part II** of this manual.

Selection of the best structure type alternative may be based in part on the lowest cost, but other requirements to be considered include:

- Site requirements (topography, alignment).
- Safety (during construction, traffic, detours).
- Structural (future widening, foundation conditions).
- Environmental (appearance, wetlands, public exposure).
- Construction (ease of construction, false work, season).
- Hydraulics (stream flow, bank and pier protection, culvert alternates).
- Life cycle costs (maintenance, durability).
- Other (commitments to officials and community, team studies).

Prior to commencing the preliminary structure design, prepare and distribute a structure selection report including an economic analysis to FHWA.

6.9 Retaining Walls

Select and design the best-suited wall type and where appropriate alternate wall designs. Request a preliminary geology report from the Geotechnical Engineer.

DDOT prefers the use of Mechanical Stabilized Earth (MSE) wall design in lieu of standard retaining walls. The designer may propose an alternative design with an approval from the Program Manager.

Private developers may use the pre-approved District's standard property walls and retaining walls or they may propose alternative design when it is designed and duly stamped by the Professional Engineer registered in the District of Columbia.

NOTE: Refer to the **Structural** chapter within **Part II** of this manual.

6.10 Noise Barrier Walls

- Select the best-suited wall type based on the noise analysis, and provide the design with the alignment, height, and configuration.
- Request the foundation investigation, and the sound walls may require a substantial foundation.
- Locate buried utilities to avoid interference with the walls.

6.11 Guiderail/Barrier Design and Review

Upgrade of substandard bridge rail should be considered on all projects. Evaluate factors concerning safety, traffic control, hazards and other constraints in the use of guiderail. The Project Manager should use an analysis to warrant the use of guiderail based on the **AASHTO Roadside Design Guide**. Consider design sequence before the placement of guiderail on projects as follows:

- Provide the clear zone as determined from the **AASHTO Roadside Design Guide**.
- Provide for slope flattening for traversable grades (4:1 slope) within the clear zone.
- Remove the obstacle or redesign it so it can be traversed safely.
- Relocate the obstacle or steep terrain feature to a point were an errant vehicle is less likely to impact, as far from the edge of travel way as practical.
- Reduce impact severity by using appropriate breakaway roadway fixtures.
- Shield the obstacle, terrain feature or water hazard with longitudinal barrier and/or crash cushion when it cannot be eliminated, relocated or redesigned.
- Delineate the obstacle or hazard when the above alternatives are not appropriate due to type of project, low design speed, low volume, scenic roadway, or historical feature.

When the Project Manager recommends guiderail, criteria in the **Roadway** chapter within **Part II** of this manual, and the **AASHTO Roadside Design Guide** should be followed. For resurfacing, guiderail should be reset to the height of 27 in. when it is less than 24 in. after the overlay. Substandard existing guiderail end sections are to be replaced with current design end treatments. Treatments must

pass the National Cooperative Highway Research Program Report No. 350 criteria. The cost of slope flattening and hazard elimination versus guiderail cost should be considered. Because guiderail is a hazard in itself, it should be installed only per the guidelines of the **AASHTO Roadside Design Guide**.

6.12 Crashworthy Bridge Rail

FHWA approved crashworthy bridge rail (must also meet the test criteria of NCHRP Report 350) must be provided on all new bridges. Rehabilitation of bridges shall use crashworthy bridge rail unless a design exception is approved. Aesthetic consideration must be given when choosing the crashworthy bridge rail. Use the District's approved crash tested rail wherever it can be used.

NOTE: If a bridge rail is to remain in place and meets current AASHTO specifications, a design decision can be documented in the project file and have approval from FHWA.

6.13 Vertical Horizontal Clearances of Structure

All highway projects shall meet or exceed minimum vertical clearances according to guidelines set by the FHWA and DDOT, as well as, **AASHTO** minimums. These clearances shall pertain to all overpasses, underpasses, railroad and transportation facilities, bicycle and pedestrian facilities, overhead lines, sign bridges, signal mast arms, navigational streams, channels, and canals

The Designer should include provisions for future widening. A formal design exception is required if less clearance than the minimum is achieved. Minimum vertical clearances are listed in Structures Chapter, in **Part II** of this manual.

Obtain approval from the District's Program Manager concerning vertical and horizontal clearances for all phases on detours and traffic shifts. Clearances to false work and shoring should be considered during construction. If minimum clearances cannot be maintained during construction, appropriate signing shall be included in the plans. Vertical clearances shall be shown on the highway construction plans for all structures.